Regulatory Review of Non-Rated” Stormwater Treatment Practices

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April 2013

MassDEP
Massachusetts Department of Environmental Protection

Stormwater Treatment Practices (STP) Not Rated by MassDEP - Summary

- To be Subject:
  - Project must be a New Development and /or Redevelopment Activity that requires the filing of a Wetlands notice of intent or 401 WQ Cert.
  - Project must be subject to Stormwater Standards at 310 CMR 10.05(6)(k) or 314 CMR 9.06(6)(a)
- Underlying Resource Area or BZ performance standards must be met
- If STP not listed in Table TSS, follow any applicable specifications listed in Stormwater Handbook (e.g. Vol. 2, Chap. 2, Proprietary Separators proposed as part of new development must only be used as a pretreatment practice and cannot be used to provide the required TSS treatment)
- Information required in Stormwater Checklist must be submitted to issuing authority (e.g. water quality volume calculations and studies validating TSS water quality treatment claims)
- Follow process described in Stormwater Handbook, Volume 2, Chapter 4

Wetland Reg. Requirements

No Scour to Resource Areas/No new untreated discharges to wetland resource area	310 CMR 10.05(6)(k)1
Attenuate peak runoff rate	310 CMR 10.05(6)(k)2
Provide stormwater recharge	310 CMR 10.05(6)(k)3
Remove TSS (surrogate)	310 CMR 10.05(6)(k)4
Maintain stormwater practices	310 CMR 10.05(6)(k)9
BMP consistent w/TMDL	Stormwater Handbook

Massachusetts Stormwater Handbook

Volume 2, Chapter 4

Proprietary Stormwater BMPs

Two Ways to Approve or Deny the Use of Proprietary Stormwater BMPs

1. MassDEP has reviewed the performance of a technology as determined by TARP or STEP and assigned a TSS removal efficiency.
    - If the conditions under which it is proposed to be used are similar to those in the performance testing, presume that the proprietary BMP achieves the assigned TSS removal rate
    - Look at sizing, flow and site conditions.
2. Issuing Authority makes a case-by-case assessment of a specific proposed use of a proprietary technology at a particular site and assigns a TSS removal efficiency.
    - Proponent must submit reports or studies showing effectiveness of BMP.
    - MassDEP strongly recommends using UMass Stormwater Technologies Clearinghouse database to ensure that reports and studies are of high quality (www.mastep.net).
    - Look at sizing, flow and site conditions.
    - For ultra-urban and constrained sites, proprietary BMPs may be the best choice.

Massachusetts Stormwater Characteristics?

Constituent	Concentration	NJCAT Tier II Protocol	What To Look For In Study
Total Suspended Solids	59.3 mg/L, average*	100 – 300 mg/L	Influent Conc. <60 mg/L
Suspended Sediment Concentration	62.5 mg/L, median**		
Particle Size Distribution	64% of particles were found to be <63 µm**	< 100 µm	PSD < 63 µm
Total Phosphorus	0.11 mg/L, median**		
Total Nitrogen	1.11 mg/L, median**		
Zinc	122 µg/L, median**		
Chloride (Annual)	822 mg/L, average**		
Chloride (Winter, Jan – Mar)	3,488 mg/L, average**		

*Breault 2002 (USGS), http://pubs.usgs.gov/wri/wri024137/pdf/wrir024137.pdf

**Derived From Smith 2010 (USGS), http://pubs.usgs.gov/sir/2009/5269/

Massachusetts Stormwater Characteristics?

Factor	Massachusetts	TARP Tier II Protocol	What To Look For In Study
Number of Storms 0.1-inch or greater	126 (Boston, daily storms, avg.)	At least 15, but preferably at least 20	The more storms the better (20 storms only represent about 15% of the year, so may be insufficient to produce representative sample)
Annual Precipitation	Varies By Location 44-inches (Boston, avg.) 52-inches (Plymouth avg.)	At least 50% of annual precipitation	At least 50% at location. Boston - at least 22-in. Plymouth – at least 26-in.
Adverse Weather (snow melt)	Dec-March period	Sampling in adverse weather	Documented that sampling included snow melt, with at least 1/3 to 1/4 of samples Dec-March
Inter-Event Period		At least 6-hrs	Documented that at least 6-hr inter-event period occurred between storms

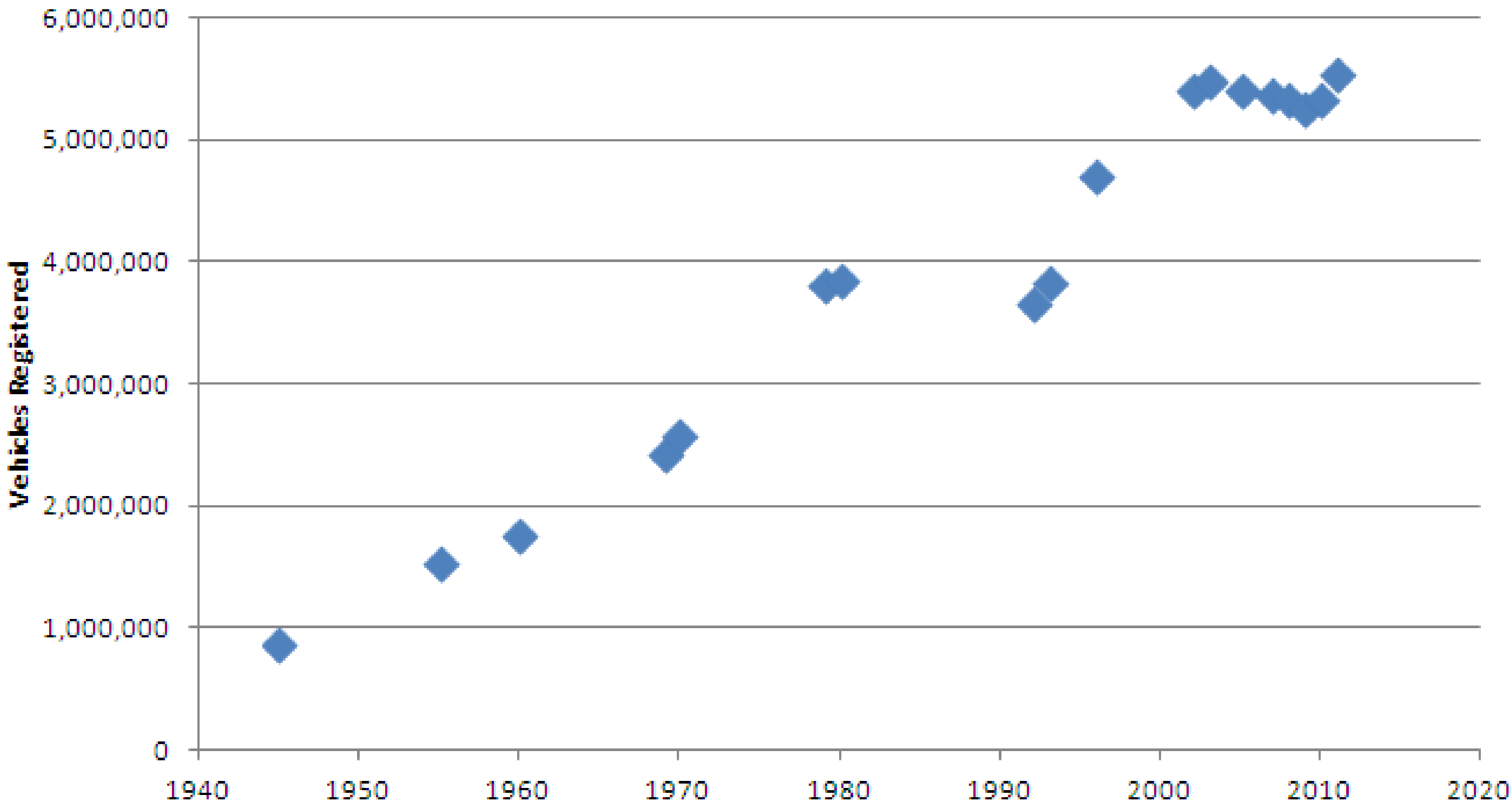
Massachusetts statistics compiled from 1981 to 2010 period

General Class	Class Name	Diameter (um)	Smith 2010 MA[9]			Selbig 2011 Madison WI[10]				NURP	EPA/Standard Methods	NJ DEP	SIL-CO-		
			Rt 119-P	Rt 95-P	Highways	Mixed Use	Parking Lots	Feeder St	onal Roof	1983	160.2/2540D	Mix	SIL 106	F-95	OK-110
			n = 18	n = 18	n = 127	n = 20	n = 94	n = 21	n = 41						
		>4000													
Gravel	Very fine gravel	4000 to 2000													
Sand	Very coarse sand	2000 to 1000				4%	5%	26%		1%					
	Coarse sand	1000 to 500										5%			
	Medium sand	500 to 250	10%	25%	14%	5%	15%	19%	10%	3%		5%			
	Fine sand	250 to 125	7%	21%	22%	7%	11%	14%	13%	3%		30%[1]		99%[6]	100%[7]
	Very fine sand	125 to 62				21%	15%	15%	9%	5%		15%[2]	20%		
Silt	Coarse silt	62 to 31	83%	55%	64%				1%						
	Medium silt	31 to 16				31%	32%	13%	3%	37%		25%[3]	75%		
	Fine silt	16 to 8							9%						
	Very fine silt	8 to 4							21%						
Clay	Coarse clay	4 to 2				18%	12%	7%	34%	37%		15%[4]	5%		
	Medium clay	2 to 1				14%	10%	6%							
	Fine clay	1 to 0.5								14%		5%[5]			
	Very fine clay	0.5 to 0.24													
	Colloids	<0.24													
d50						42 µm	54 µm	200 µm	95 µm	10 µm[11]	NA	<100 µm	22 µm	120 µm	102 µm

Selbig 2011 (USGS), http://pubs.usgs.gov/of/2011/1052/pdf/OFR20111052.pdf

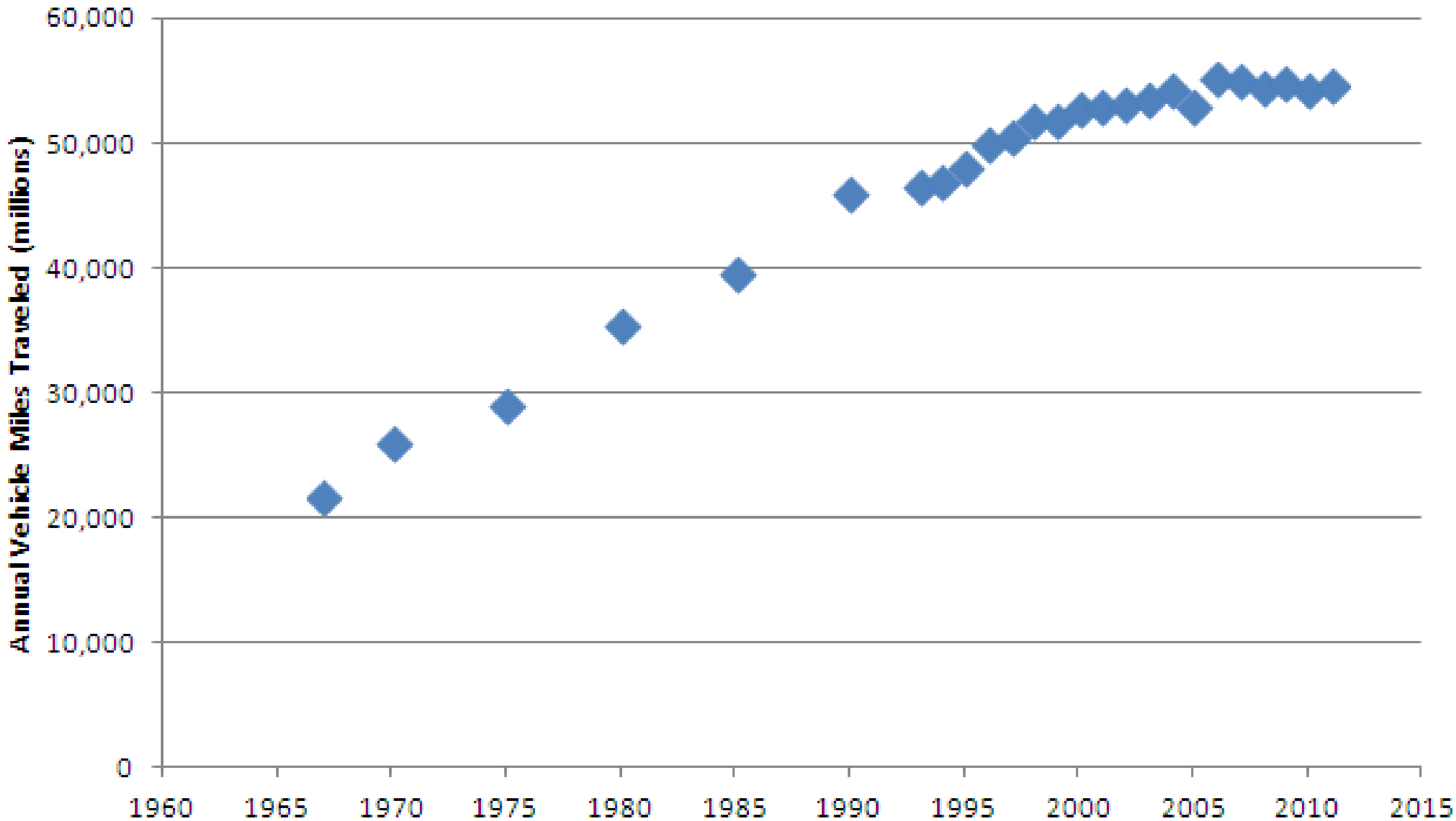
Smith 2010 (USGS), http://pubs.usgs.gov/sir/2009/5269/

Number of Vehicles Registered In Massachusetts By Year



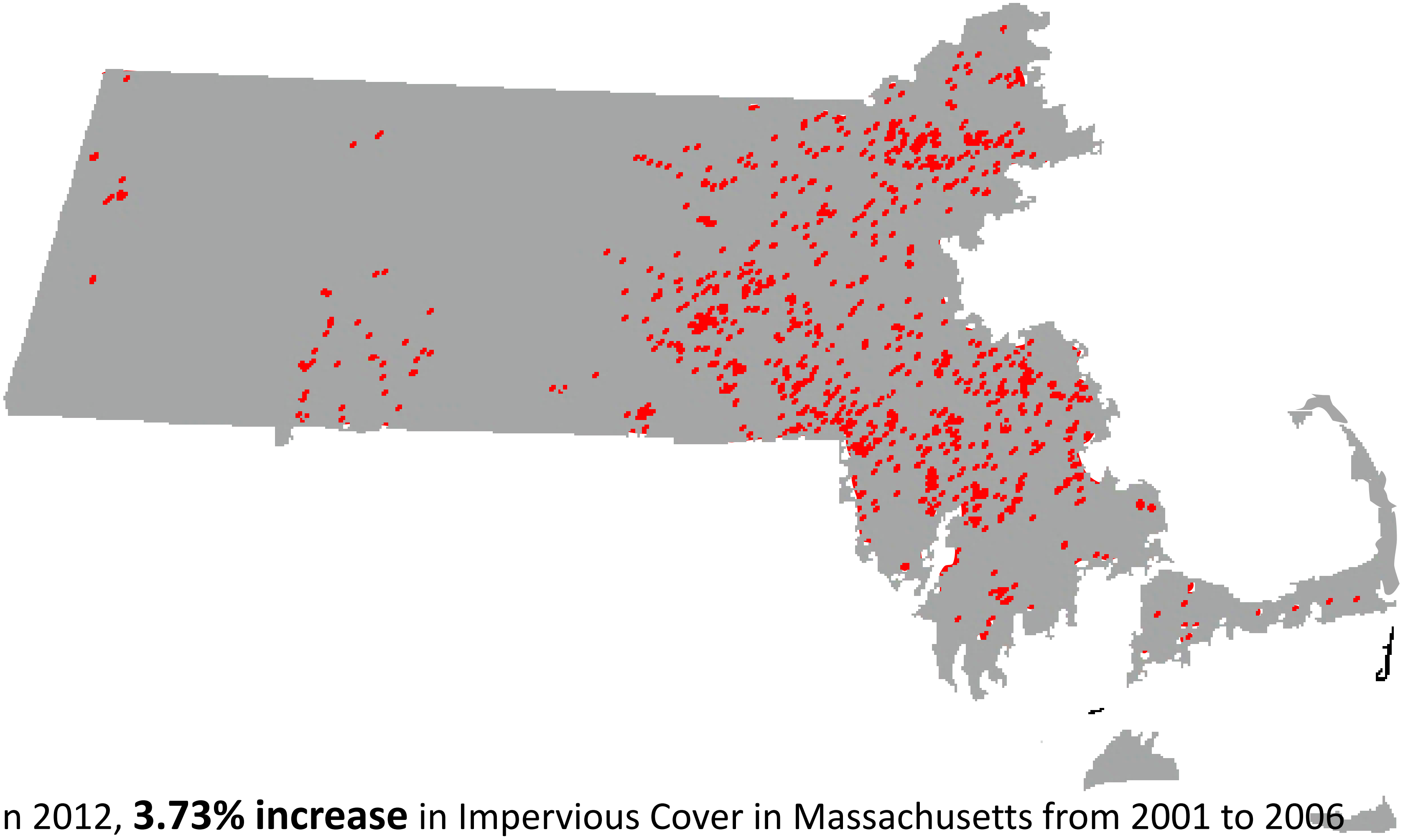
Compiled from FHWA annual highway statistics, Form MV-1

Annual Vehicle Miles Traveled in Massachusetts By Year



Compiled from FHWA annual highway statistics, Form MV-2

Impervious Area Increase 2001-2006



Xian 2012, **3.73% increase** in Impervious Cover in Massachusetts from 2001 to 2006

See: http://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=506291

Table TSS

TSS Removal Efficiencies for Best Management Practices	
Best Management Practice (BMP)	TSS Removal Efficiency
Non-Structural Pretreatment BMPs	
Street Sweeping	0-10%, See Volume 2, Chapter 1.
Structural Pretreatment BMPs	
Deep Sump Catch Basins	25% only if used for pretreatment and only if off-line
Oil Grit Separator	25% only if used for pretreatment and only if off-line
Proprietary Separators	Varies – see Volume 2, Chapter 4.
Sediment Forebays	25% if used for pretreatment
Vegetated filter strips	10% if at least 25 feet wide, 45% if at least 50 feet wide
Treatment BMPs	
Bioretention Areas including rain gardens	90% provided it is combined with adequate pretreatment
Constructed Stormwater Wetlands	80% provided it is combined with a sediment forebay
Extended Dry Detention Basins	50% provided it is combined with a sediment forebay
Gravel Wetlands	80% provided it is combined with a sediment forebay
Proprietary Media Filters	Varies – see Volume 2, Chapter 4
Sand/Organic Filters	80% provided it is combined with sediment forebay
Treebox filter	80% provided it is combined with adequate pretreatment
Wet Basins	80% provided it is combined with sediment forebay

- Lists MassDEP Assigned TSS Credits by Practice Type

Practices That Don't Have A MassDEP Assigned TSS Rating

Some LID Practices
Proprietary / Manufactured Treatment Practices By Brand Name

ESSD / LID Practices

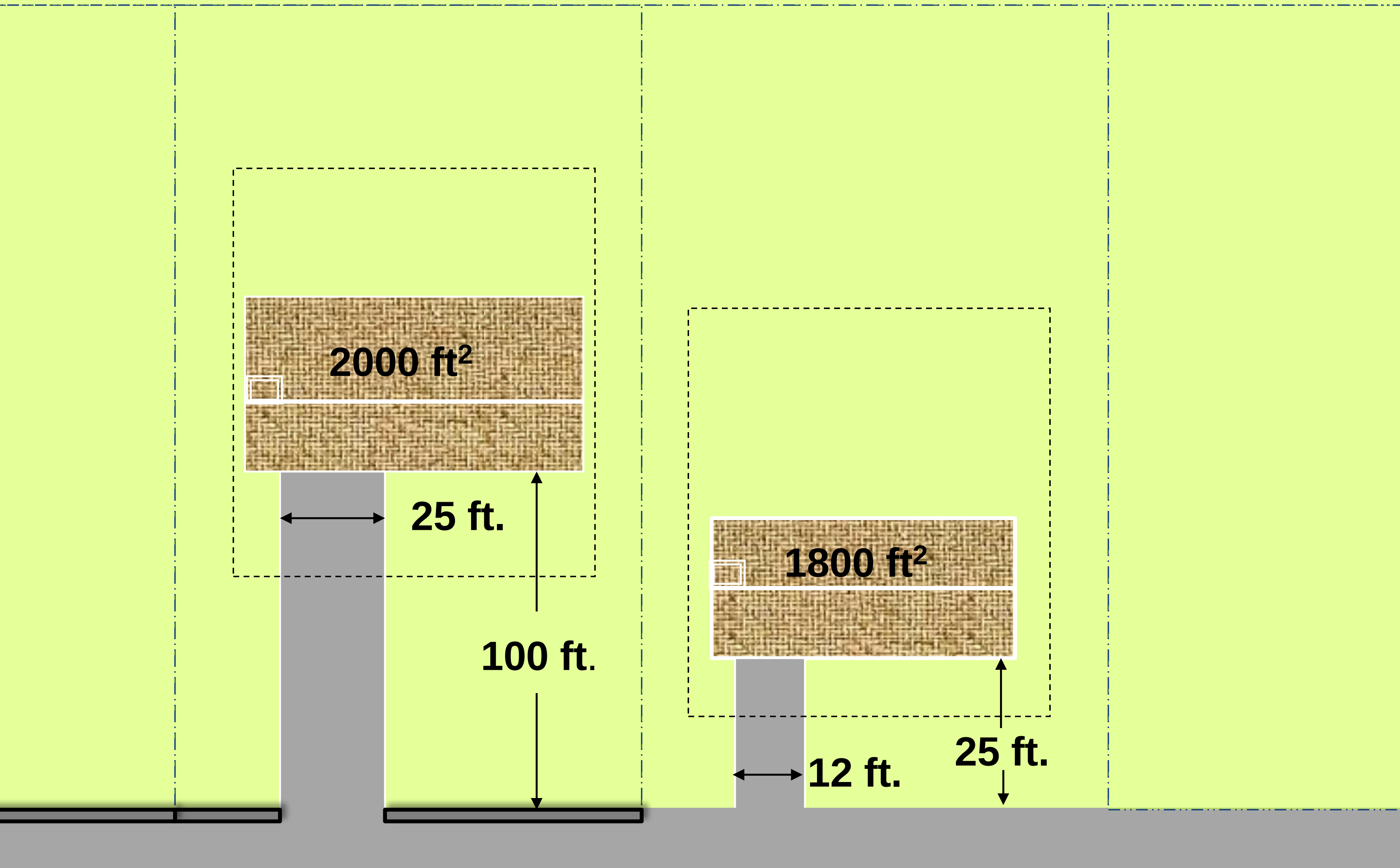
Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☐ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☐ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens) **DEP Credit: 90% TSS w/PT**
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs) **DEP Credit: 80% TSS w/PT**
- ☐ Treebox Filter **DEP Credit: 80% TSS w/PT**

ESSD / LID Practices



LOW IMPACT DEVELOPMENT SITE DESIGN CREDITS

AVAILABLE CREDITS:

CREDIT 1. Environmentally Sensitive Development
CREDIT 2. Rooftop Runoff Directed to Qualifying Pervious Area
CREDIT 3. Roadway, Driveway or Parking Lot Runoff Directed to Qualifying Pervious Area

"Qualifying Pervious Areas" are defined as natural or landscaped vegetated areas fully stabilized, with runoff characteristics at or lower than the NRCS Runoff Curve Numbers in the table set forth below. The Qualifying Pervious Area may be located in the outer 50-foot portion of a wetland buffer zone. However, it must not be located in the inner 50-foot portion of a wetland buffer zone (that portion of the buffer zone immediately adjacent to a wetland).

Maximum NRCS Runoff Curve Numbers for Qualifying Pervious Area

Cover Type	HSG A	HSG B	HSG C
Natural: Woods Good Condition	30	55	70
Natural: Brush Good Condition	30	48	65

Manufactured / Proprietary Stormwater Treatment Products

Disclaimer

Mention or Depiction of Any Brand Names Does Not Constitute Endorsement or Non-Endorsement of Product Performance

Proprietary Separators

Description: A proprietary separator is a flow-through structure with a settling or separation unit to remove sediments and other pollutants. They typically use the power of swirling or flowing water to separate floatables and coarser sediments, are typically designed and manufactured by private businesses, and come in different sizes to accommodate different design storms and flow conditions. Some rely solely on gravity separation and contain no swirl chamber. Since proprietary separators can be placed in almost any location on a site, they are particularly useful when either site constraints prevent the use of other stormwater techniques or as part of a larger treatment train. The effectiveness of proprietary separators varies greatly by size and design, so make sure that the units are sized correctly for the site's soil conditions and flow profiles, otherwise the unit will not work as designed.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	Provides no peak flow attenuation
3 - Recharge	Provides no groundwater recharge
4 - TSS Removal	Varies by unit. Must be used for pretreatment and be placed first in the treatment train to receive TSS removal credit. Follow procedures described in Chapter 4 to determine TSS credit.

Advantages/Benefits:

- Removes coarser sediment.
- Useful on constrained sites.
- Can be custom-designed to fit specific needs of a specific site.

Disadvantages/Limitations:

Proprietary Media Filters

Description: Media Filters are typically proprietary two-chambered underground concrete vaults that reduce both TSS and other pollutants (e.g., organics, heavy metals, soluble nutrients). After larger particles settle out in the first chamber, stormwater flows through the specific filter media in the second chamber. Selection of the specific media largely depends on the pollutant targeted.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	N/A
3 - Recharge	N/A
4 - TSS Removal	See Vol. 2, Chapter 4
5 - Higher Pollutant Loading	Suitable as pretreatment device
6 - Discharges near or to Critical Areas	Suitable as pretreatment device

Advantages/Benefits:

- Suitable for specialized applications, such as industrial sites, for specific target pollutants
- Preferred for redevelopments or in the ultra-urban setting when LID or larger conventional practices are not practical

Disadvantages/Limitations:

- May require more maintenance
- Performance varies depending upon media
- TSS removal variable, depending on media
- "Wet" systems that are designed to retain water can cause mosquito and vector problems unless access points are sealed

Verifications

- STEP (Strategic Envirotechnology Partnership)
  - STEP no longer serves as a regulatory verification
  - Stormwater reviews were sunset on Jan. 1, 2011
- MASTEP (Mass. Stormwater Technologies Evaluation Project)
  - MASTEP does not serve as a regulatory verification
  - MASTEP only analyzes scientific adequacy of studies
- TARP (Technology and Reciprocity Partnership)
  - TARP does not serve as a regulatory verification
  - No written reciprocities granted by MassDEP (as of April 2013).

The Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs

STEP: Sunset Jan. 1, 2011

TRANSITION TO A STORMWATER PERFORMANCE RATING SYSTEM

Background

Government and industry efforts to prevent pollution from stormwater have come a long way since 1998 when this Executive Office was a partner in the Massachusetts Strategic Envirotechnology Partnership (STEP) and STEP issued independent technology assessment reports on the performance of three proprietary stormwater control products. Due to funding cutbacks, STEP no longer exists as a program to evaluate new technologies or to update existing reports. This creates an uneven playing field, with no new technology vendor able to go through a STEP review or obtain any of the marketing advantages that the STEP fact sheets or assessment reports offer. The existing reports are static, allowing for no additional models to be evaluated or for updated data collection protocols to be applied.

Also, while the STEP program was unique in its day, commonly accepted criteria for collecting data and evaluating performance information have changed in ten years. The Commonwealth partnered with other states (in a Technology Acceptance and Reciprocity Partnership or TARP) to create a performance demonstration pathway that relies on a common methodology. This uniform method, the TARP Stormwater field testing protocol, is a contemporary, scientifically credible and defensible method that is today recognized as the current standard evaluation tool in this state and in others. Other protocols may be deemed equivalent by MassDEP and as technologies develop and science evolves, TARP may be replaced with a newer evaluation tool.

Stormwater Performance Ratings in Massachusetts using TARP

When data from the TARP field studies become available, Massachusetts' staff will evaluate the results and

See: http://www.mass.gov/eea/docs/eea/step/040309-step.pdf

described below.

MASTEP $\neq$ STEP


MDE
TARP
Technology Acceptance and Reciprocity Partnership
TARP: No written reciprocities granted

Massachusetts Stormwater Handbook

Chapter 4

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- MassDEP strongly recommends using UMass Stormwater Technologies Clearinghouse database to ensure that reports and studies are of high quality (www.mastep.net).
- Look at sizing, flow and site conditions.
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Required To Be Submitted:

- ❑ Identify whether treatment practice qualifies for new development, critical area, and /or LHPPL requirements
- ❑ WQV Calculations
- ❑ TSS removal calculations
- ❑ Peak flow rate attenuation calculations
- ❑ Recharge calculations
- ❑ Complete description of proposed practice
- ❑ **Studies validating performance claims**
- ❑ Bypass method for stormwater flow in excess of WQV
- ❑ O/M Plan

Water Quality Volume (WQV)

- Studies need to characterize TSS removal efficiency for the first ½ inch or 1-inch WQV for regulatory purposes. The WQV is a runoff volume, not a precip. volume.
- Studies that analyze Suspended Sediment Concentration (SSC) without also analyzing TSS are not sufficient to validate TSS removal claims for regulatory purposes.
- Some studies characterize SSC as “Bulk TSS.” “Bulk TSS” $\neq$ TSS.
- LAB studies may not be sufficient by themselves to verify TSS removal claims for regulatory purposes in so far as the TARP Tier II testing protocol requires FIELD study.

Possible Study Sources

- UMass MASTEP database
- UNH Stormwater Center
- International SW BMP Database
- ETV
- USGS

UMass MASTEP

See: http://mastep.net

UNH Stormwater Center

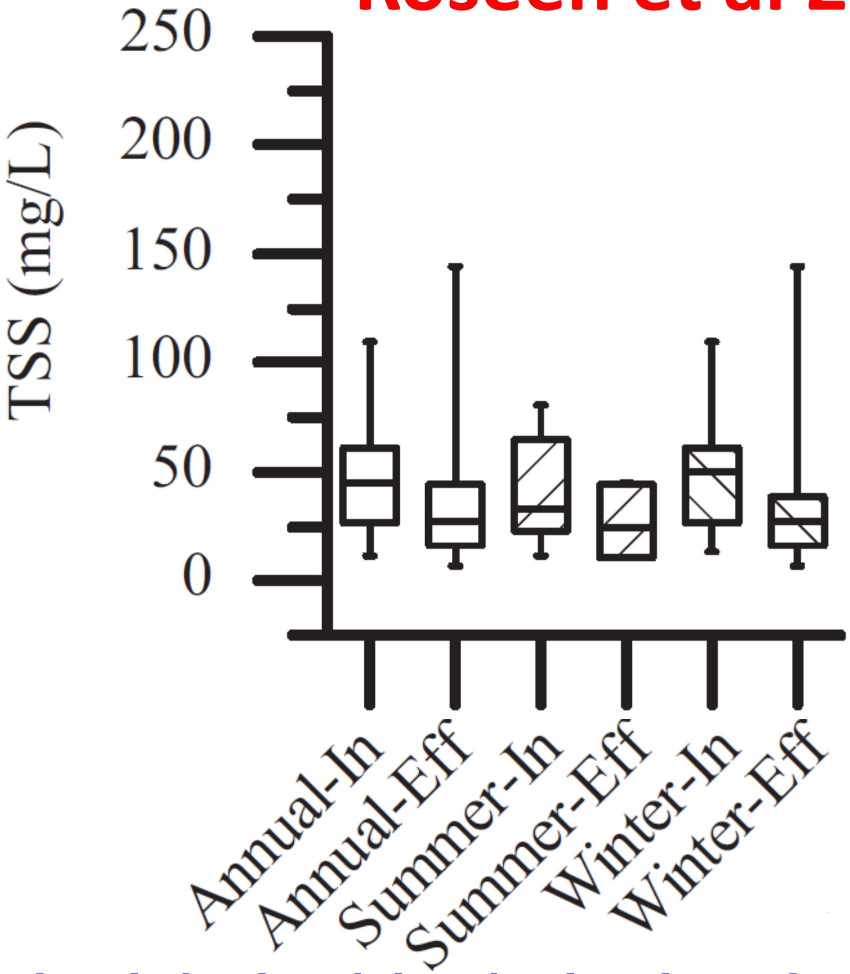
UNH Biannual Report

UNHSC Measured Median Pollutant Removal Efficiencies																	
	TSS Total Suspended Solids (mg/l)			TPH-D Total Petroleum Hydrocarbons in the Diesel Range (ug/l)			NO3-N (DIN) Dissolved Inorganic Nitrogen (mg/l)			TZn Total Zinc (mg/l)			TP Total Phosphorus (mg/l)			Average Annual Peak Flow Reduction	Average Annual Lag Time
Treatment Unit Description	Influent	Effluent	% Removal	Influent	Effluent	% Removal	Influent	Effluent	% Removal	Influent	Effluent	% Removal	Influent	Effluent	% Removal	% Reduction	Minutes
Conventional Treatment Technologies																	
Retention Pond	55	30	68%	710	100	82%	0.3	0.2	33%	0.05	0.01	68%	0.09	0.11	NT	86	455
Detention Pond	77	16	79%	490	165	74%	0.3	0.2	25%	0.03	0.02	50%	0.05	0.05	NT	93	639
Stone (rip-rap) Swale	30	15	50%	580	380	33%	0.4	0.7	NT	0.07	0.02	64%	-	-	-	6	7
Vegetated Swale	48	16	56%	710	207	82%	0.3	0.3	NT	0.04	0.02	40%	0.08	0.10	NT	52	38
Berm Swale	51	23	50%	637	61	81%	0.2	0.3	NT	0.03	0.02	50%	0.07	0.09	NT	16	58
Deep Sump Catch Basin	48	34	9%	510	440	14%	0.2	0.3	NT	0.04	0.04	NT	0.08	0.07	NT	NT	NT
Manufactured Treatment Devices																	
ADS Infiltration Unit	49	BDL	99%	766	BDL	99%	0.3	0.9	NT	0.05	BDL	99%	0.12	0.02	81%	87	228
StormTech	87	13	83%	750	45	91%	0.3	0.5	NT	0.03	0.01	67%	0.07	0.03	52%	78	235
Aquifilter	28	11	62%	573	156	66%	0.3	0.3	NT	0.04	0.02	43%	0.07	0.05	24%	NT	NT
Online Hydrodynamic Separators	41	29	29%	774	442	42%	0.4	0.4	NT	0.05	0.04	26%	0.09	0.11	NT	NT	NT
Offline Hydrodynamic Separators (HDS)	120	21	75%	570	180	64%	0.2	0.3	NT	0.03	0.02	21%	0.05	0.05	NT	NT	NT
Low Impact Development (LID)																	
Surface Sand Filter	45	19	51%	788	17	98%	0.3	0.4	NT	0.06	0.01	77%	0.12	0.06	33%	69	187

See: http://www.unh.edu/unhsc/

Seasonal Separator Performance

Roseen et al 2009



See:

http://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/pubs_specs_info/jee_3_09_unhsc_cold_climate.pdf

International Stormwater BMP Database

Manufactured Devices - Physical (derived from 2012 ISWBMP Summary)	Influent Median Reported	Effluent Median Reported	Units	% Removal
TSS	33.6	29.7	mg/L	12%
Copper	12.41	11.35	ug/L	9%
Total Lead	7.56	5.84	ug/L	23%
Dissolved Lead	2.24	2.66	ug/L	-19%
Total Zinc	75.2	57.6	ug/L	23%
Dissolved Zinc	72.9	71.8	ug/L	2%
Total Phosphorus	0.35	0.22	mg/L	37%
Dissolved Phosphorus	0.11	0.09	mg/L	18%
TKN	1.74	1.63	mg/L	6%
No_x as Nitrogen	0.42	0.36	mg/L	14%

See: http://www.bmpdatabase.org/

ISWBMP 2012, Manufactured Devices Performance Summary

ETV

Practice	Model	Location	# Storm	DA (ac)	TSS (% removal)	SSC (% removal)	TP (% removal)	NO3 (% removal)	Zinc (% removal)
Bay Savers Technologies, Inc.	10K	GA	15	10	33	82	27	16	--
Crystal Stream Water Quality Vault	1056	GA	15	4.05	21	89	40	25	--
DownStream Defender	6 ft. Ø	WI	20	5.5	22	33	--	--	--
StormFilter Catch Basin	CBSF	MI	16	0.16	11	9	--	--	29
StormFilter with Perlite Media		GA	15	0.7	50	50	50	-13	52
StormFilter with ZPG Media		WI	20	0.19	46	92	30	--	64
StormScreen	16x8 ft	GA	15	7.3	--	--	--	--	--
TerreKleen	09	PA	15	2.5	35	32	--	--	--
Vortechs	1000	WI	18	0.25	35	61	21	--	24

See: http://www.epa.gov/nrmrl/std/etv/vt-wqp.html#SWSATD

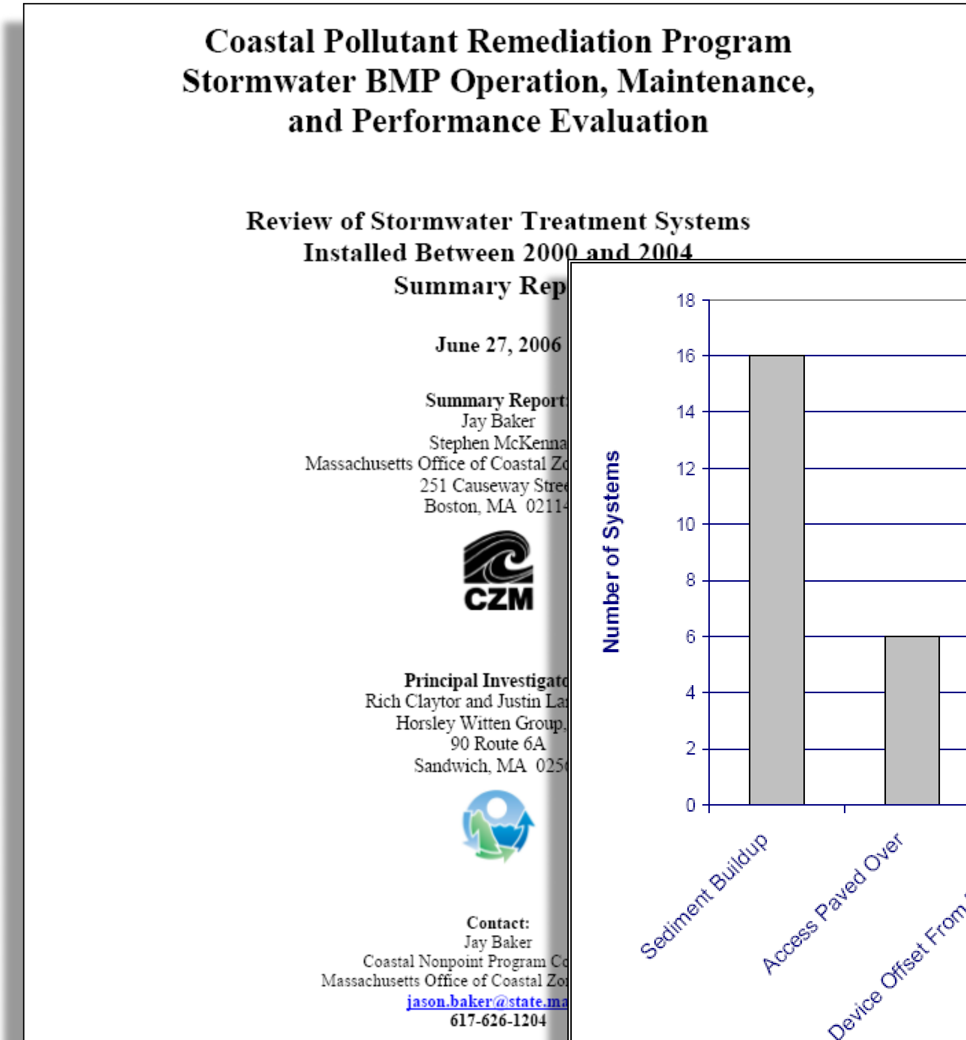
USGS

Practice	Model	Location	# Storms	DA (ac)	TSS (% removal)	SSC (% removal)	TP (% removal)	Zinc (% removal)
CDS	NR	SC	12	1.11	54	60	2	32
Crystal Stream	NR	SC	12	2.77	50	60	36	56
Downstream Defender	6 ft.	WI	23	1.91	-5 to 12	19		-9 to -19
StormCeptor	NR	SC	13	2.24	30	51	32	39
StormCeptor (w/o winter/ snow melt)	STC6000	WI	45	4.3	>33		17	17
StormCeptor (only winter/ snow melt)*	STC6000	WI	15	4.3	5			
Vortechs	NR	SC	12	5.9	46	43	14	20
Vortechs	1000	WI	18	0.25	25	49	21	24

See: http://water.usgs.gov/pubs

*Bannerman 2005, using USGS data set
Conlon 2008
Horwatich 2010
Horwatich 2012
Waschbusch 1999

Effects of Lack of Maintenance



Coastal Pollutant Remediation Program
Stormwater BMP Operation, Maintenance, and Performance Evaluation

Review of Stormwater Treatment Systems
Installed Between 2000 and 2004
Summary Rep

June 27, 2006

Summary Report
Jay Baker
Stephen McKenna
Massachusetts Office of Coastal Zo
251 Causeway Stre
Boston, MA 0211

CZM

Principal Investigato
Rich Claytor and Justin La
Horsley Witten Group,
90 Route 6A
Sandwich, MA 025

Contact:
Jay Baker
Coastal Nonpoint Program Co
Massachusetts Office of Coastal Zo
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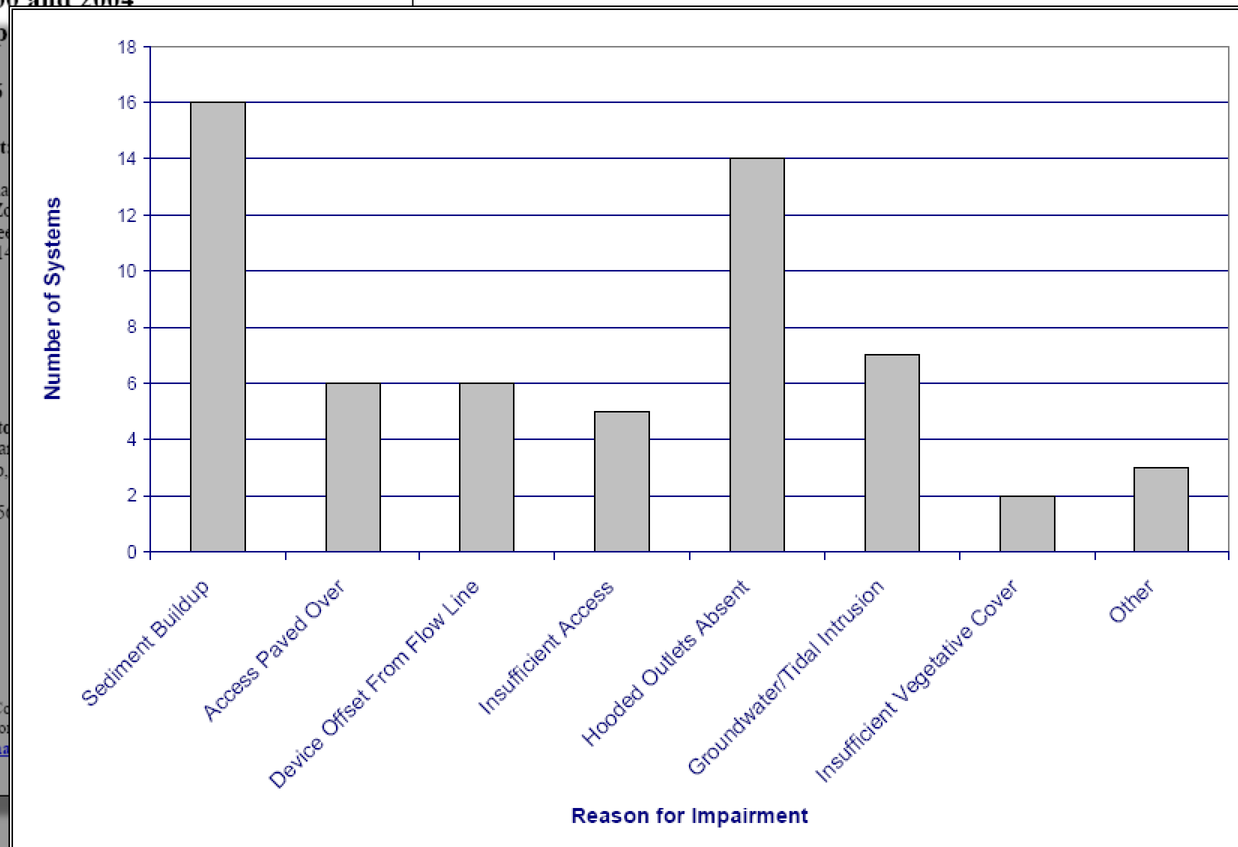
Only 27% of the systems inspected were rated functional



See: http://www.mass.gov/czm/docs/pdf/cpr/cpr_bmp_report.pdf

“Approved For Use” Claims

THIRSTY DUCK LTD.
Thirsty Duck Buoyant Flow Control Devices (BFDs) function as floating outlets capable of delivering a constant flow rate by gravity, regardless of water surface elevation. When sized for the optimum discharge rate, detention volume can be minimized by as much as 50%! Thirsty Duck BFDs are university-tested, self-skimming, easily pass common debris, and are made from materials specially selected for the stormwater system environment. They are also approved for use by the Florida, Washington, Massachusetts, and New York Departments of Transportation.
www.thirsty-duck.com

310 CMR 10.05(6)(k) requires Massachusetts Stormwater Handbook specifications to be used – Ignore “Approved for Use” Claims

END